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CONTENTS

Seed Tuber Treatments for Potatoes ..... G. H. Coons 433
The Fungous Flora of Pine Seed Rods ..... Annis E. Rathbun 439
Briefer Articles:
Additional List of State and National Quarantines Against the White Pine Blister Rust ..... Ror G. Pierce 454
Reviews 457
Phytopathological Notes 460
Appendix 463
Literature on Plant Diseases 464

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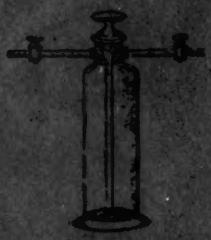

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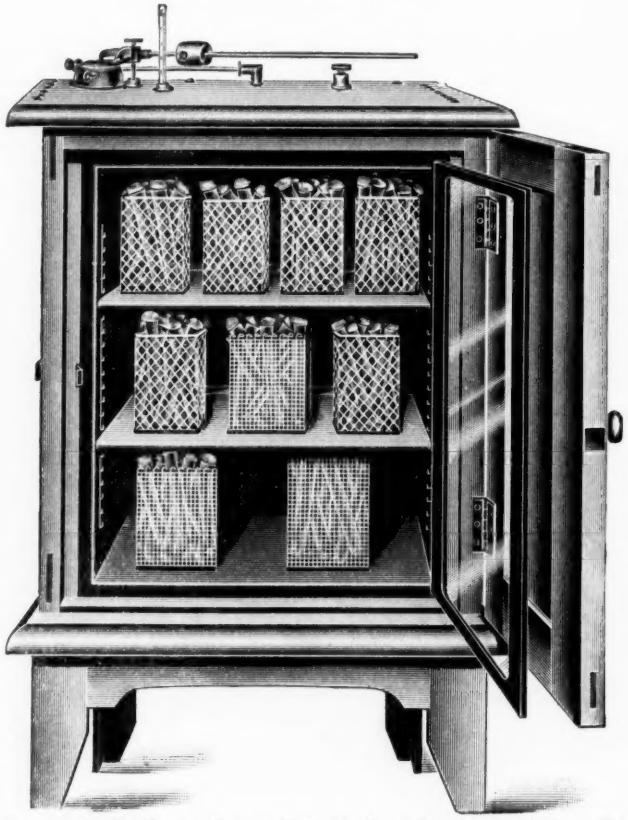

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PHYTOPATHOLOGY

VOLUME VIII NUMBER 9

SEPTEMBER, 1918

SEED TUBER TREATMENTS FOR POTATOES

G. H. Coons

When the potato scab was assigned to a bacterial cause by Bolley in 1890, this concept cleared away much of the confusion of the old literature and pointed out a rational plan of treatment. In his first paper, Bolley (1) suggested as a control measure the use of disinfectants such as used in medical practice. Following the work of Thaxter (2) in which the causal organism of scab was isolated, there developed an extensive literature consisting for the most part of detailed tests of various germicides, and as a result of this great body of work, there crystallized out the definite program of tuber treatments which has been recognized by the Department of Agriculture and by all the Experiment Stations. Much of this work, and especially that concerned with soil amelioration, has been reviewed by Lutman and Cunningham (3) in their bulletin on the potato scab organism.

The standard treatment first proposed called for a one and one-half hour soaking of sound, whole potatoes in corrosive sublimate solution made up of approximately 1 part to 1000 parts of water. In the last two decades, as a result of the investigations of Arthur (4), formaldehyde at the rate of 1 part of commercial formaldehyde solution 40 per cent to 240 parts water has almost completely replaced the corrosive sublimate in general practice. In 1913 Gloyer (5) recognizing the great extent of damage caused by Rhizoctonia, compared the two chemicals critically by laboratory tests, and demonstrated the superiority of the corrosive sublimate so far as the control of black scurf is concerned. Accordingly in the last four years increasingly large percentages of growers have been reverting to the older treatment and so far as reports are available, with satisfactory results.

The whole matter of the utility of seed tuber treatments was brought to the foreground by the monograph of Lutman and Cunningham, already referred to. These authors showed that the scab organism does not prop-

erly belong in the loosely defined fungous group, Oospora, where Thaxter had provisionally placed it, but that it is really one of the soil inhabiting bacteria, long described and known to soil bacteriologists as *Actinomyces chromogenus* Gasperini. This change in nomenclature and the new viewpoint developed by the assignment of the organism to the thread bacteria has been commonly accepted by plant pathologists, and has been seen to be in harmony with the previously known relations of the scab organism (or at least of the scabbiness of crops) to excessive liming or to alkalinity in soils—the restriction of bacterial growth by, and the tolerance of fungous growth to, acid conditions being general throughout the groups, bacteria and fungi respectively. The stand of the authors on soil infestation with the specific cause of potato scab has not been so clearly put as to

FIG. 1. CROP GROWN FROM SCABBY TUBERS, UNTREATED. PLAT 1

lead to uniform acceptance, nor is there full internal evidence in their bulletin for their conclusion "the practicability of seed potato disinfection is therefore questionable" (l. c., p. 48). The hypothesis of the authors "There is always the possibility, however, that special conditions are necessary for infection and that some strains of this organism will produce scab much more readily than others," although questioned by the writers themselves[1] has been largely accepted by plant pathologists as explaining the escape of potato tubers from complete scabbiness from

[1] "Inoculation trials with a number of strains of the chromogenus type seem to indicate clearly, however, that those forms with well marked characters, especially the ability to darken the media will readily produce scab when brought into contact with a growing potato tuber." (*L. c.* page 47.)

what is surely an ubiquitous species in the soil as well as explaining the indisputable favorable results of seed disinfection in the past.

It is very evident that the value of seed-tuber disinfection has been brought into question and a number of new problems as to the organism involved, its occurrence in virgin soils, etc., have been opened up.

In almost parallel lines, investigations of the Rhizoctonia disease have brought some evidence to indicate that with Rhizoctonia we are dealing with an organism occurring naturally in our soils, and while the existence of strains differing widely in pathogenicity has been proved, yet the

FIG. 2. CROP GROWN FROM CLEAN TUBERS, NOT TREATED. PLAT 14

question of advisability of tuber treatment presents similar problems to those referred to above.

The old literature contains conflicting statements as to the effects of seed treatments upon stand. There exists also among farmers a difference of opinion in this regard, some declaring that the treated potatoes come up earlier and stronger, while others have had experience which has shown at least a week's difference in favor of the untreated potatoes. There are also cases where injury to stand has been reported. This point is made by Lutman and Cunningham in their argument against seed treatment in cases where there is but a light attack of scab on the

seed tubers (l.c., p. 49). In the majority of cases, the slight retardation of the sprouting adjusts itself before the season has progressed far, and the actual killing of sprouts by treatment is off-set, in part at least, by the decimation of plants which occurs in untreated seed by the attacks of both scab and Rhizoctonia, especially the latter. While the most of the complaints have been brought against formaldehyde—perhaps owing to its wider use—and while doubtless many of the complaints have been chargeable to errors in treatment, such as use of solutions of too great strength, or for prolonged periods, or treatment after cutting, there still

FIG. 3. CROP GROWN FROM SCABBY TUBERS WHICH WERE SOAKED FOR FIFTEEN MINUTES IN FORMALDEHYDE, 1–240. PLAT 3

remain cases where actual injury to seed tubers has resulted from treatment.

This possibility is recognized in the Wisconsin recommendations (Milward (6)) in which it is advised that the tubers be rinsed in clear water after treatment with formaldehyde or corrosive sublimate solution.

From still another point of view the methods in vogue for the control of these superficially borne tuber diseases needs reconsideration. It is a fact that these treatments are widely neglected in the great potato-producing areas in several states. This omission of seed treatment does not result from ignorance of the value of the treatment nor lack of demon-

stration of its effectiveness, but results rather from the fact that in the press of farm operations in the spring, any tedious or time-consuming plant-disease-control measure is apt to be crowded out. In such sections, fields of from 10 to 20 acres are common, and since such an acreage would involve the treatment of from 200 to 400 bushels of seed tubers, using the ordinary farm equipment of barrels and water supply, it is evident that the matter of seed treatment under the present standard recommendations of one and one-half to two hours for soaking of seed means that one man will need to devote nearly a week to the actual details of seed treatment.

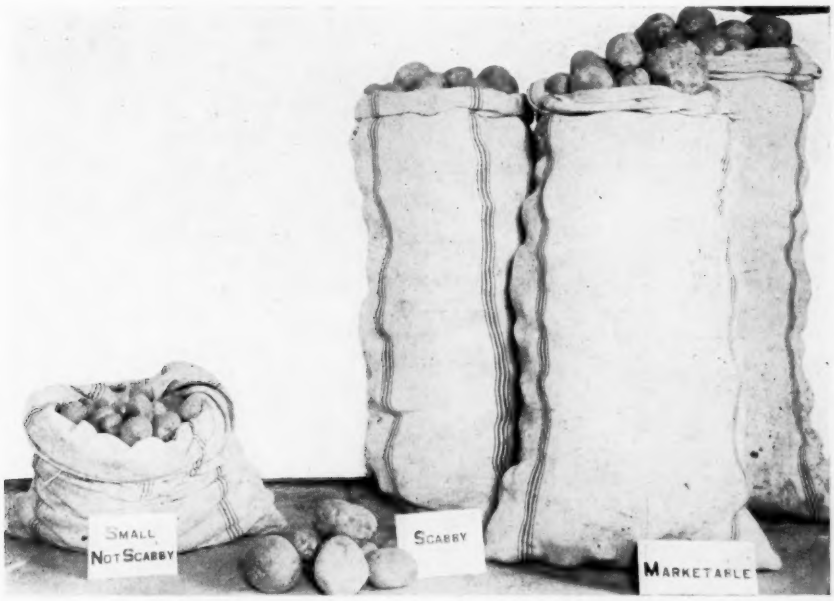

FIG. 4. CROP GROWN FROM SCABBY TUBERS WHICH WERE SOAKED FOR ONE AND ONE-HALF HOURS IN FORMALDEHYDE, 1–240. PLAT 5.

In common practice it is found to be almost impossible for the farmer to keep the treatment abreas with the cutting. In general, the present requirements for treating have slowed up farm operations at the busiest time of the year, and accordingly we find that on some of the best farms this very important detail of potato production is omitted entirely.

While some variations from standard methods have been tested and recommended by Taft and his assistants (7, 8, corrosive sublimate, 1–2000, one-half hour) no marked change in the method of handling tubers has thus far developed.

With these various considerations in mind and noting that the times used in the superficial disinfection of potato tubers were greatly in excess of those allotted in sanitation work for the maximum efficiency of action of either disinfectant, the following field experiments were undertaken to determine if possible improvements in the old method as well as to test again the whole matter of the desirability of seed treatments.

FIG. 5. CROP GROWN FROM SCURFED TUBERS WHICH WERE SOAKED ONE-HALF HOUR IN CORROSIVE SUBLIMATE, 1–1000. PLAT 18.

CONDITIONS OF THE EXPERIMENT

The seed stock used in the tests came from three sources, called respectively in the tables A, B and C. The first-named consisted of tubers of the Rural type with a slight admixture of Beauty of Hebron potatoes which had been grown at Cheboygan, Michigan. The second group "B" were of the Rural type and had been obtained from New Brunswick, Canada. The "C" potatoes were Rural type obtained from a local warehouse and were chosen for the high percentage of Rhizoctonia and scab shown. They were obtained when it became evident that sufficient diseased tubers were not obtainable to carry out all the tests planned with the first two named lots of seed.

The tubers were sorted into three grades—clean, that is free from all scab or black scurf blemish; conspicuously scabby; and conspicuously scurfed. Since enough tubers of "A" badly scurfed with Rhizoctonia but

without scab were not available, some in which scab was also present were used in the last named group.

The tubers were treated with solutions in large jars in approximately 2-peck lots and because of weather conditions were not planted for several days. During this delay the treated tubers were spread out in trays to dry. The tubers were cut by hand as planted, a tuber unit system being followed throughout. This feature was not an essential part of the experiment, but had as its object a study of the performance of individual tubers of the seed stock.

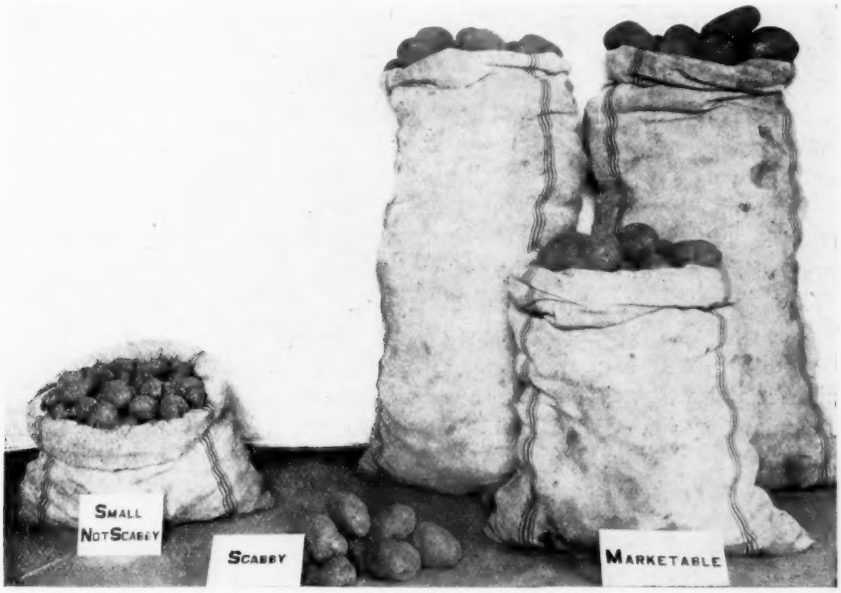

FIG. 6. CROP GROWN FROM SCURFED TUBERS WHICH WERE SOAKED ONE AND ONE-HALF HOURS IN CORROSIVE SUBLIMATE, 1–1000. PLAT 11

The soil used is a sandy loam which for the preceding four years had been in alfalfa. The success of alfalfa on this land would seem to indicate that the soil was not markedly "acid." There is no record of any but legumes and grain crops upon this land. The plats were approximately forty feet by thirty feet, and were laid out on a strip of land so that plats 1 and 2, 3 and 4, etc., were side by side. The land is slightly rolling and the plats 1, 2, 3 and 4 were considerably lower than the rest. The soil in these plats is considerably blacker than that in the other plats. The plats 5 to 10 inclusive presented practically identical conditions. Plats 11 to 18 were on still higher sloping ground which is still more sandy than

that used for the other plats. The alfalfa sod had been thinner and the preparation of the ground was more uniform.

The plats were given ordinary culture and were sprayed several times. In this connection it should be pointed out that the lateness of the planting season and the earliness of the frost militated against a proper yield. The yield obtained was at the rate of one hundred bushels to the acre.

The potatoes were dug, sacked, and taken to the cellar where records as to scabbiness were made during the next month. Every tuber from each plat was examined for scab and graded for size. This work was done by student labor, working under instructions to count as scabby any tuber with any corky scab spots whatsoever. No attempt was made to record the percentage of scab due to Rhizoctonia. The counts for Rhizoctonia were made by the writer. Approximately 1 bushel of the marketable tubers from each plat was washed and examined for Rhizoctonia resting bodies while still wet. No attempt was made in these determinations to consider the black scab spots due to Rhizoctonia. These were not prominent, however. During this determination for Rhizoctonia the accuracy of the sorting out of scab was checked and it was found that the work of sorting out the scabby tubers had been done accurately.

The following results were obtained (table 1). The treatment given will be clear from the statement except in a couple of cases. The potatoes "sprinkled" with formaldehyde 1–240 were spread out in a tray and the disinfectant was applied with a sprinkling pot. The tubers were then moved and sprinkled again. The tray was covered for two hours and then the potatoes were spread out to dry. The tubers sprayed with concentrated formaldehyde were given approximately 15 cc. of formaldehyde per bushel (fifty strokes of the atomizer), being turned about slightly during the treatment. They were then covered for two hours. They were subsequently aired by being spread out in a tray. The hot solutions were started at the temperature indicated and the tubers, at room temperature, dropped in. No attempt was made to hold the temperature constant.

The criterion adopted for determination of efficiency of Rhizoctonia control, i.e., presence of Rhizoctonia resting bodies, may be open to some question. Field conditions were such that no determinations of amount of Rhizoctonia were possible aside from the record of the stand. If the figures are to be criticised, the criticism must certainly be in favor of the treatments for undoubtedly some killing of plants in the untreated plats occurred, and the effects of this are not shown in the figures given. The tubers were left in the ground nearly a month after the tops were killed by frost, and in view of the wetness of the soil proper conditions for resting-body formation must have been presented.

TABLE 1

Treatments of seed tubers with various disinfectants

PLAT	SOURCE OF SEED STOCK	QUALITY OF SEED TUBERS	TREATMENT	MARKETABLE SIZE, CLEAN	LARGE, SCABBY	SMALL, NOT SCABBY	SMALL, SCABBY	PER CENT SCABBY	NUMBER OF TUBERS EXAMINED FOR RHIZOCTONIA	NUMBER OF TUBERS FOUND WITH RHIZOCTONIA	PER CENT OF RHIZOCTONIA	STAND; PER CENT
1[1]	A	Scabby	Not treated	330	250	278	134	38.7	128	1	00.8	95
2	A	Clean	Not treated	854	118	280	49	12.7	96	17	10.8	95
3	A	Scabby	Soaked 15 minutes formaldehyde solution, 1–240	776	7	419	2	00.7	131	3	2.2	95
4	A	Clean	Soaked 15 minutes formaldehyde solution, 1–240	884	2	360	0	00.1	237	6	2.5	98
5	B	Scabby	Soaked 1½ hours formaldehyde solution, 1–240.	874	12	153	0	1.1	92	0	0	95
6[4]	B	Clean	Soaked 1½ hours formaldehyde solution, 1–240.	848	90	358	7	7.4	152	3	1.9	95
7	A	Scabby	Sprinkled thoroughly formaldehyde solution, 1–240.	1058	25	593	17	2.2	160	1	00.8	98
8	A	Clean	Sprinkled thoroughly formaldehyde solution, 1–240	1203	54	372	5	3.2	140	1	00.8	98
9[2]	A	Scabby	Sprayed (atomizer) formaldehyde, concentrate 15 cc. per bushel	725	1	167	0	00.1	88	0	0	80
10[2]	A	Clean	Sprayed (atomizer) formaldehyde, concentrate 15 cc. per bushel	734	5	288	0	00.4	92	0	0	80
11[3]	C	Scurfed	Soaked 1½ hours. Corrosive sublimate, 1–1000	785	9	338	0	1.0	248	9	3.6	85
12	A	Scabby	Soaked 1½ hours 5 per cent bleaching powder solution.	931	93	357	18	8.5	113	0	0	95
13	C	Scurfed	No treatment	705	62	217	6	6.7	141	20	14.1	80
14	A	Clean	No treatment	664	46	363	4	4.6	157	0	0	95

TABLE 1—*Continued*

PLAT	SOURCE OF SEED STOCK	QUALITY OF SEED TUBERS	TREATMENT	MARKETABLE SIZE, CLEAN	LARGE, SCABBY	SMALL, NOT SCABBY	SMALL, SCABBY	PER CENT SCABBY	NUMBER OF TUBERS EXAMINED FOR RHIZOCTONIA	NUMBER OF TUBERS FOUND WITH RHIZOCTONIA	PER CENT OF RHIZOCTONIA	STAND: PER CENT
15[2]	C	Scurfed	Sprayed concentrated formaldehyde solution. Rate 15 cc. per bushel	308	10	77	0	**25**	108	8	**74**	40
16	C	Scurfed	Soaked 1½ hours formaldehyde solution, 1–240.	777	10	360	2	**11**	118	9	**76**	80
17[3]	A and C	Scurfed	Soaked 5 minutes in corrosive sublimate, 1–1000, 54°C. at start.	758	1	266	0	**01**	103	1	**09**	80
18[3]	A	Scurfed	Soaked ½ hour in corrosive sublimate, 1–1000.	1190	4	455	0	**02**	133	5	**37**	98

[1] *Plat 1.* The extremely low yield, and the poor quality of the tubers from this plat was especially noteworthy. Many of the tubers were small. Distorted, cracked tubers were common.

[2] *Plats 9, 10, 15.* The sprayed tubers showed marked formaldehyde injury before planting and doubtless the severity of the treatment was responsible for the poor stand. In plat 15 the additional effect of the uncontrolled black scurf is evident.

[3] *Plats 11, 17, 18.* It would seem that the lessening of stand in these plats was due to corrosive sublimate injury, especially when the results of plat 18 are considered. In a similar manner the stand in plat 17 seemed due to injury from the hot solution.

[4] *Plat 6.* It will be noticed that plat 6 showed in spite of the treatment indicated (soaking in formaldehyde solution 1–240 for one and one-half hours) 7.4 per cent of scab. It seems probable from the results of other treatments recorded, especially the results of plat 5 which was located beside it, and which was from the same seed stock, differing only in that the tubers used were scabby, that in this case the treatment planned had been omitted through error. The results from this plat have not been considered at all in arriving at the conclusions drawn.

Figures 1 to 6 illustrate certain of the results that were obtained in the control of scab. The tubers were sorted into the various classes, were weighed and then photographed.

The following conclusions seem justified from the results obtained:

1. Untreated, scabby tubers in clean ground gave a poor yield of low grade, distorted tubers, in which there was a great predominance of small tubers and an excessive amount of scab.

2. Untreated, clean tubers from the same lot of seed stock from which the above-mentioned scabby tubers had been sorted, gave when planted in clean ground a considerable amount of scab.

3. Formaldehyde treatment of either scabby or clean tubers gave, with clean ground, complete control of scab. Soaking for a period of fifteen minutes in formaldehyde solution 1–240 was as efficient as soaking for one and one-half hours.

4. Formaldehyde solution 1–240 had a slight controlling effect on Rhizoctonia but for efficient control with this disinfectant, clean sorting was also necessary.[2]

5. The value, for the control of Rhizoctonia, of sorting a seed stock to free it from tubers with Rhizoctonia resting bodies, even without disinfection, is demonstrated.

6. Corrosive sublimate, 1–1000, for either one-half hour or one and one-half hours controlled both scab and black scurf. When the solution was heated to 54°C. with a treatment of five minutes' duration, efficient control of both scab and black scurf was obtained.

7. Corrosive sublimate, at one and one-half hours' duration gave a very much poorer stand than the one-half hour treatment. Treatment with hot corrosive sublimate also gave a poor stand.

8. Bleaching powder, 5 per cent solution had no bad effects on the stand, but had but little if any beneficial effect in controlling scab. It was not tested against Rhizoctonia.

9. The value in reducing scab of sprinkling tubers with dilute formaldehyde, (1–240) was demonstrated. This method may, with modification, be developed to be of value to growers handling large acreages.

10. Scab was controlled by spraying tubers with concentrated formaldehyde. It should be pointed out that with such a treatment the tubers were badly pitted and this effect was reflected in the stand.

11. The experiments here reported seem to show the important source of both Rhizoctonia and scab was infested seed, the soil furnishing a negligible amount of infectious material, if any.

The writer would not extend the last conclusion beyond soils of similar history or type, nor would he question in the least the careful experiments and observations previously recorded which show the persistence of soil infestation. That soils richer in humus might carry a heavy natural infestation of scab and black scurf-producing strains of organisms is neither affirmed nor denied, this being a question that must be answered by future tests.

[2] That is, sorting that frees a seed stock from tubers showing Rhizoctonia resting bodies.

The writer believes the whole matter of seed tuber treatment should certainly be carefully tested before any backward step be taken for hypothetical reasons. It would certainly seem that utmost conservatism should be practiced before the tested results as to the value of seed treatment for potatoes which have accumulated at practically every experiment station, as well as on countless farms, are abandoned. That the above experiments have been made on a sandy soil of the type which readily tends to become acid is clearly recognized and the fact that the nature of this soil type may play a rôle in the decisive character of the figures obtained is conceded. The soil, however, represents fairly well much of the characteristic potato soil of this and neighboring states, and it is believed that the conclusions drawn have a wide applicability. The need for tests with a great variety of soil types is apparent.

The shortened treatments seem entirely feasible and being in line with well known practices in sanitation work should be adopted in order that seed tuber treatments may be made readily by farmers. It should be noted that two options for tuber treatment are open, formaldehyde solution, 1–240 for fifteen minutes, coupled with close sorting to remove all tubers with black scurf; or corrosive sublimate, 1–1000 for one-half hour, the latter treatment being effective against both scab and Rhizoctonia without close sorting.

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THE FUNGOUS FLORA OF PINE SEED BEDS

ANNIE E. RATHBUN

PART I. FUNGOUS FLORA OF THE SOIL

I. Introduction

About four years ago a nursery for seedlings of *Pinus resinosa* Ait. and *P. ponderosa* Dougl. was established at the Metcalf Botanical Garden of Brown University, Providence, R. I. Each season almost all of the seedling pines have damped off.

The writer began the present problem, a preliminary account of which is given in this paper, with the hope of ascertaining whether the soil of the nursery contains any fungi, besides Fusarium, which are capable of producing damping off. An attempt was also made to find out at what depth the various fungi occur and how widely they are distributed in the nursery and the surrounding meadow. Later, for the sake of comparison, a brief study was made of two lots of soil from another part of the state.

In recent years many fungi have been isolated from the soil, but very few, so far as can be learned, have been reported definitely below a depth of 8 inches. Waksman (1) states that he found *Zygorrhynchus vuillemini* at all depths from 1 to 30 inches, but that most of the "other organisms" were obtained from the upper 8 inches. He adds "in most samples taken at depths of 12, 20 or 30 inches only Zygorrhynchus would develop from the soil upon the plate, with no other organism." Miss Taylor (2) has reported Fusarium at practically every depth from 1 to 24 inches.

Most other investigators of soil fungi either procured their samples from the upper 8 inches of soil or do not state at what depth they took them. Goddard (3) discovered Fusarium, Mucor, and Trichoderma at various depths to 14 cm., but does not mention at what depths he found the other fungi which he describes. Werkenthin (4) collected soil from 1 to 7 inches, but states that he found no fungous organisms at depths of 5, 6 and 7 inches. He adds that the same species of fungi are found from each of the first 4 inches. Jensen (5) also made isolations from the upper 8 inches of soil, but does not report at what depths the various fungi occurred. Beckwith (6) obtained the material for his investigations 2 inches below the surface. McLean (7) (8) and Miss Dale (9) do not mention the particular depths at which they found fungi.

II. Present investigations

A. Description of soil from which samples were collected. 1. Soil at the Metcalf Botanical Garden, Providence, R. I. The land is almost level, sloping gently to the east and the northeast. The top soil consists of a layer of medium light colored, sandy loam, which is from 10 to 14 inches in depth. Beneath this is a bed of coarse yellow sand from 3 to 10 feet deep. This is underlaid by hardpan.

2. Soil of the R. H. I. Goddard Estate, East Greenwich, R. I. This estate is situated about 15 miles in a straight line from the Botanical Garden. The top soil of that portion of the estate where lot F was collected is rich, dark, sandy loam about 2 feet in thickness. Lot G was procured from top soil consisting of light sandy loam, running to a depth of 8 to 10 inches. Both top soils are underlaid with sand and gravel to a depth of at least 10 feet.

B. Methods and time of obtaining soil samples. Several lots of soil, A, B, C, D, E, F and G were collected, each sample of each lot containing $\frac{1}{2}$ to 1 pint of soil. The first (A) was taken in October and the second (B) in December, 1916; the third (C) in January, the fourth (D) in February and the fifth (E), the sixth (F) and the seventh (G) in March, 1917. Lots A, B, C, D and E came from the nursery while lots F and G were taken from the R. H. I. Goddard Estate, East Greenwich, R. I.

Lot A was collected in meadow land which has not been cultivated for a period of twenty years. It was ploughed in the spring of 1916 and has not been cultivated since. This meadow land is situated near the fence on the south side of the nursery about 75 feet from the pine seed bed where all the seedlings had damped off. Lot C came from sod land which was ploughed in the spring of 1913 and has since remained uncultivated. When this collection was made the soil was frozen to a depth of 10 inches. Lot D was procured from the meadow land along the fence at the northeast corner of the nursery about 75 feet from the pine seed beds. The upper 14 inches of this soil were frozen. Lot E was collected in the meadow land from which lot A came, about 15 feet southeast of the entrance to the nursery and about 10 feet from pine seed beds in which damping off had occurred.

Lot F came from a vegetable garden at East Greenwich and Lot G from a nearby garden which was planted with corn in 1916. The soil of both gardens had been heavily fertilized with stable dressing almost every year, while peat muck had also been added to the latter. The ground had thawed to a depth of 6 to 8 inches at the time the samples were taken.

The soil samples were collected in the following manner. First a trench, the dimensions of which were about 4 feet by 2 feet by 5 feet was dug.

The trench was always 5 or 6 inches deeper than the lowest depth at which soil was collected. One side of it was dug perpendicular. A series of undercuts about 3 inches apart were made beginning at the bottom of the trench. The soil was scraped by means of a sterile scraper from the under side of the shelf and allowed to drop into sterilized baking powder cans or Mason jars. Thus the danger of contamination from above was greatly minimized.

C. Media. Five kinds of agar—soil extract, oat meal, corn meal, prune and pine twig—were used.

1. The soil agar was prepared according to the formula described by Jensen (5) as "soil extract agar II." This medium was most satisfactory for both poured plates and stab cultures. Upon it all the fungi produced characteristic colonies, while Fusarium usually caused it to turn very rosy red. The soil extract gave the best results when freshly prepared.

2. The oat meal agar was prepared according to a formula in general use in the botanical laboratory of Brown University. The fungi grew upon this medium almost as well as on soil agar, but the color reaction in the case of Fusarium was less marked. Because of its opaqueness, it was less convenient for poured plates.

3. Corn meal agar was made by substituting Rhode Island corn meal—a white unbolted meal—for the oat meal of the above medium (2). This agar was very unsatisfactory for poured plates and, even in case of stab cultures, little additional data could be secured by its use.

4. Pine twig agar was prepared according to Shear's (10) formula for chestnut twig agar except for the fact that shredded agar melted over a free flame was used in place of agar flour melted by steaming. This agar was tried out primarily to ascertain whether any of the soil organisms would grow especially well on a medium containing an extract of pine twigs. Fusarium, Zygorrhynchus, and some of the other fungi fruited upon it in tubes. Upon poured plates the colonies were small and of little variety. It was not satisfactory as a whole.

5. Prune agar was made according to Shear's (10) prune agar formula with the modification noted above for pine twig agar. This agar was very unsatisfactory, for few colonies grew upon it. Bacteria were more troublesome on this medium than on the others.

D. Isolation from the soil. The cultures were made in the manner described below. A can of soil was taken into the culture chamber and its contents was emptied into a sterilized Mason pint jar and shaken vigorously. With a sterilized spatula, which held approximately 0.55 of a gram, varying slightly with amount of moisture present, soil was taken out and placed in a bottle containing 100 cc. of distilled water.

Each bottle was shaken well and, before the soil had time to settle, 1 cc.

of the mixture was taken out by means of a sterile pipette. This was added to 10 cc. of melted soil agar and then plated. At least two plates were made for each sample of each lot. In order to test the growth of the fungi on other media and to ascertain whether other organisms could be secured, additional plates were made from time to time.

In case of lot D, not only additional media, but also an additional method of plating was used. One cubic centimeter of the soil solution was poured into a Petri dish. To this was added 10 cc. of melted soil agar and the two were mixed by a rotatory movement of the Petri dish. Since no more colonies were secured by this method than by the former, it was later abandoned.

Fungous and bacterial colonies usually began to appear at the end of two days. At this time the plates were examined and the fungi isolated by the ordinary bacterial method for obtaining pure cultures. The bacterial colonies were very abundant at first, but within four or five days the fungous colonies had overgrown them.

III. Results of the present investigation

A variety of fungi appeared in all the plates. It is assumed that all those forms appearing are soil forms, but contamination may have taken place in some instances, in spite of all care taken to avoid it. Some of the slow growing fungi were crowded out by the rapid growing forms; some were undoubtedly lost in the process of isolation, while others still await identification.

The following tables give a list of the fungi which have been identified thus far from the various depths and, except in the case of lot A, the approximate number of colonies which appeared on the various plates. An asterisk (*) in the column following the name of a fungus indicates the depth at which it was found and shows that no estimate of colonies was made.

TABLE I

Lot A. October 9, 1916

	MEADOW LAND, BOTANICAL GARDEN									
Depth in inches	1	3	6	10	14	16	22	26	30	34
Aspergillus niger	*									
Mucor botryoides					*					
Mucor heterogamus	*		*	*	*	*	*			*
Mucor sp.	*	*		*	*					
Penicillia	*	*	*	*	*	*	*	*	*	*
Trichoderma koningi	*	*	*			*	*		*	
Zygorrhynchus vuillemini		*	*	*	*	*	*	*		

TABLE 2

Lot B. December 5, 1916

		PINE SEED BED, BOTANICAL GARDEN									
Depth in inches		Surface	4	8	12	16	20	24	28	32	34
Totals	A	512	272	163	144	52	17	327	74	10	137
	B	431	198	160	124	53	21	189	51	39	38
Aspergillus niger	A				1				1		2
	B										
Fusarium sp[1]	A	70	7	4				1			
	B	34	12	2		1					
Mucor heterogamus	A	1	2								
	B	1	1						1		
Mucor sp	A	6	3						1		1
	B	5	5						2		1
Mycogene?	A				1						
	B										
Penicillia	A	15[0]	14[0]	49[0]	104[0]	6[0]			1[0]		125[0]
			9[00]	3[00]	9[00]	2[00]	2[00]	2[00]	5[00]	1[00]	7[00]
			26**			1**	13**	240**			1**
	B	21[0]	28[0]	25[0]	100[0]	25[0]			4[0]	30[0]	1[0]
			9[00]			3[00]	2[00]	97[00]	1[00]	3[00]	34[00]
			27**			3**	13**				1**
Spicaria sp	A										1
	B									*	
Trichoderma koningi	A	400	62	68	7	22		58			
	B	350	45	25		7		32	*		
Zygorrhynchus vuillemini	A		2	3	2	3					
	B		3	3	5		1	*	*		

[1] = Macro- and micro-conidia of Fusarium.
[0] = dull green Penicillium.
[00] = dark green Penicillium.
** = yellow Penicillium.

TABLE 3

Lot C. January 23, 1917

		UNCULTIVATED GROUND, BOTANICAL GARDEN										
Depth in inches		1	2	4	6-8	10	14	18	32	26	30	34
Totals	A	300	500	180	220	160	120	73	33	170	124	63
	B	270	520	180	260	160	160	62	47	149	120	115
Aspergillus niger	A			2				0	*			1
	B			1				1				
Fusarium sp.[1]	A	27	23	5	27	4	2	2		0		
	B	29	27	9	36	2	0	2		1		
Mucor heterogamus	A	2										1
	B								*	1		
Penicillia	A	100	200	34	80	39	39	30	13	28	100	21
	B	100	100	54	70	44	53	42	17	18	95	9
Trichoderma koningi	A	92	225	49	90	37	21	13	10	125	*	32
	B	94	219	80	100	60	25	5	25	40		100
Yeast	A							1			2	
	B							0		*	0	
Zygorrhynchus vuillemini	A	3	14	10	8	10	5	8	4	1		2
	B	4	17	21	4	9	6	6	2	2		1

[1] Macro- and micro-conidia of Fusarium.

It can be seen from tables 1 to 7 that no fungi known to cause damping off were found in lot A. In the succeeding lots Fusarium was found at practically all depths from the surface to 38 inches below though not in every lot. Both macro- and micro-conidia were present in all cases, the microconidia invariably appearing first. Unlike Miss Taylor (2), the writer found no chlamydospores. Fusarium is approximately of uniform abundance in each of the upper 8 inches of soil, while in the lower depths the quantity gradually decreases.

Trichoderma koningi was the most abundant fungus found, at least n regard to the number of colonies. It was among the last of the colonies to appear, growing on top of the others, while *Zygorrhynchus vuillemini* and *Mucor heterogamus* were among the first to develop. A red yeast was found at depths below 12 inches, under conditions which suggest an anaerobic organism.

It will be noted from tables 6 and 7 that many of the different kinds of fungi found in the soil of the Metcalf Botanical Garden were also found in that of the R. H. I. Goddard Estate.

TABLE 4

Lot D. February 20, 1917

		MEADOW LAND, BOTANICAL GARDEN							
Depth in inches		Surface	4	8	12	16	20	24	28
Totals, February 23, 1917	A	184	240	83	48	18	16	19	3
	B	208	188	58	48	22	6	17	5
	C	200	220	86	41	25	5	14	6
	D			2	0	1	0	0	
	E			14	9	9	4	0	
Totals, March 2, 1917	A	354	280	120	170	189	49	39	9
	B	320	260	228	110	189	37	38	10
	C	250	275	130	88	114	55	90	8
	D			35	32	32	8	7	
	E			25	42	40	16	3	
Aspergillus niger	A					3			
	B								
	C								
Fusarium sp.[1]	A	39	21	13	1	1	1	1	
	B	23	19	14	1	2	0	1	
	C	26	17	4	0	0	1	0	
Mucor botryoides	A								
	B					1	1	1	
	C								
Mucor heterogamus	A	3	1	1	1				
	B	1	0	2	0	*			
	C	2	2	1	2				
Penicillia[2]	A	6	7		47		16	7	2
	B	3	0	74	36	37		5	
	C	9	5		30	48		5	
Rhizopus nigricans	A						1		
	B								
	C								
Spicaria (silvatica?)	A					17	9	2	3
	B			12		38	3	5	6
	C			4	5	5	11	4	5
Trichoderma koningi	A	225	180		100	143			
	B	240	200	78	60	42			
	C	180	165	79		32		73	

TABLE 4—*Continued*

Depth in inches		MEADOW LAND, BOTANICAL GARDEN							
		Surface	4	8	12	16	20	24	28
Yeast	A					2	3	5	4
	B					1	4	6	2
	C					3	3	1	1
Zygorrhynchus vuillemini	A	20	25	18	7	4	2	1	
	B	13	27	13	13	4	1	1	*
	C	10	25	12	6	3	2		

[1] Macro- and micro-conidia of Fusarium.
[2] Penicillia mostly of 2 sorts.
A, B, C = soil agar.
D = pine agar.
E = prune agar.

TABLE 5

Lot E. March 16, 1917

Depth in inches		MEADOW LAND, BOTANICAL GARDEN							
		Surface	4	8	12	16	20	34	38	44
Total, March 23, 1917	A	468	300	248	50	71	99	100	61	99
	B	452	325	280	86	52	92	85	39	88
Total, March 27, 1917	A	501	339	262	105	133	169	141	71	231
	B	497	357	301	52	189	151	168	127	187
Fusarium sp[1]	A	22	17	7	3	4	6	9	3	
	B	14	18	2		1	4	7	5	
Mucor heterogamus	A	4		2		5		4	1	
	B	5		1		8	1	1		
Mucor sp	A					1			2	
	B					2				
(Oospora lactis)?	A					2		20		1
	B					4		12		1
Penicillia[2]	A	20	42	32		4	7	*	4	32
	B	37	31	44	2	13	21		3	22
Rhizopus nigricans	A						1			
	B							1		

[1] Macro- and micro-spores of Fusarium.
[2] Penicillia, yellow, dark and dull green.

TABLE 5—*Continued*

Depth in inches		MEADOW LAND, BOTANICAL GARDEN							
		Surface	4	8	12	16	20	34	38	44
Spicaria (silvatica?)	A			41	5	14	32	14	12	23
	B			27	19	17	13	38	9	20
Trichoderma koningi	A	400	257	173	80	87	112	76	31	153
	B	400	269	197	5	127	91	101	89	128
Yeast	A						3	1	2	3
	B						1	2	1	2
Zygorrhynchus vuillemini	A		3	3	12	8	6	2	4	3
	B		9	8	8	6	5	1	4	1

TABLE 6

Lot F. March 10, 1917

Depth in thickness		GARDEN, R. H. I. GODDARD ESTATE			
		1	4	8	10
Totals	A	232	175	125	115
	B	253	189	105	98
Fusarium sp.[1]	A	38	41	30	33
	B	36	25	38	26
Mucor heterogamus	A	5	4	3	
	B	2	2	1	
Mucor sp.	A	2			
	B	1		*	
Oospora lactis?	A	3	3	2	3
	B	2	1	1	
Penicillia[2]	A	35	18	19	35
	B	22	29	33	4
Trichoderma koningi	A	70	81	30	20
	B	65	75	19	17
Zygorrhynchus vuillemini	A	5	10	3	2
	B	7	12	8	7

[1] Macro- and micro-conidia of Fusarium.

[2] Penicillia, mostly dull or dark green.

TABLE 7

Lot G. March 10, 1917

Depth in inches		GARDEN R. H. I. GODDARD ESTATE			
		Surface–1	4	6	10–12
Totals	A	375	305	197	129
	B	393	295	183	140
Fusarium sp.[1]	A	61	35		
	B	44	29		
Mucor botryoides	A				
	B	1			2
Mucor heterogamus	A	8			
	B	7			
Mucor sp.	A	1			
	B	1			
Mycogene?	A				
	B		1		
Oospora lactis?	A				3
	B				4
Penicillia	A	28	50	23	16
	B	45	42	29	17
Spicaria (silvatica?)	A				44
	B				57
Trichoderma koningi	A	127	143	95	20
	B	139	165	87	17
Yeast	A				4
	B				2
Zygorrhynchus vuillemini	A		20	19	17
	B		19	17	19

[1] Macro- and micro-conidia of Fusarium.

PART II. DISSEMINATION OF SOIL FUNGI

I. Introduction

The second part of the present investigation was undertaken with the idea of finding some explanation for the presence of the fungi at the various depths in the soil.

Beckwith (6) states that the distribution of fungi in the soil depends upon the amount of moisture and the character of the soil. In support of this hypothesis he gives tables recording the monthly precipitation, the light, and the mean temperature for his region. A similar table is given below because, although it does not seem to explain the occurrence of the

TABLE 8

	1916								1917	
	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Light	6	8	6	12	14	13	15	14	9	7
Light partly cloudy	16	9	10	13	12	11	6	8	5	11
Cloudy	9	13	15	6	4	7	9	8	17	10
Mean temperature	57.0	62.8	71.4	70.8	63.4	53.9	41.2	31.4	29.6	25.0
Monthly precipitation	3.85	4.20	6.37	0.78	0.86	2.39	1.92	3.03	3.01	1.97

fungi at the various depths in the Metcalf Botanical Garden, it may be valuable for comparison after the problem has been further investigated.

The data for this table was furnished by the United States Weather Bureau, in Providence, which is situated about a mile and a half from the garden.

Miss Taylor (2) states that earthworms may be responsible for the presence of Fusarium in the soil. The present investigation seems to confirm this suggestion.

II. Methods.

1. Method, time and place of collecting grubs and worms. Grubs and earthworms were taken at the same time and at the various depths at which the samples of soil were collected. These were brought to the laboratory in the cans of dirt or in other sterilized containers.

2. Methods of isolation. The worms and grubs were thoroughly washed in both tap and distilled water. Then a portion of the contents of the alimentary canals was taken by means of sterile needles and, in case of the worms and grubs collected January 23, 1917, transferred to tubes of soil agar. The various fungi were isolated by the usual method for obtaining pure cultures. This method of transfer was not very satisfactory because the rapid-growing fungi crowded out the slower-growing.

In case of the worms and grubs collected later, the contents of the alimentary canals were transferred to tubes of melted soil agar and then plated. This method was very satisfactory.

III. Results

The results of these isolations are tabulated in Table 9.

From the above table it can be seen that many of the same kinds of fungi isolated from the soil in our cultures can also be isolated from the alimentary canals of worms and grubs. Cultures of a May beetle, which was found hibernating at a depth of 12 inches, revealed but one viable fungus. It seems that fungi are carried in the form of spores by grubs and earthworms. This assumption is based upon the fact that a microscopic examination of the contents of the alimentary canals of worms and grubs revealed spores of various fungi, but no hyphae. Among the spores discovered in the alimentary canal of an earthworm collected at a depth of 44 inches were Fusarium chlamydospores. Possibly spores and bits of mycelium may also wash down burrows of animals, worms, grubs and other insects and the hyphae of parasitic or saprophytic fungi may pass or be carried down on roots of plants.

SUMMARY OF PARTS I AND II

1. Many fungi occur in the soil at various depths from 1 to 44 inches. (See table 10.)
2. With the exception of Fusarium, no fungus known to cause damping off has yet been isolated from the soil of the nursery.
3. Grubs and earthworms are carriers of the spores of soil fungi.
4. Some soil fungi may possibly be facultative anaerobes; this point needs investigation.[1]

[1] The above investigations were conducted in partial requirement for the degree of Master of Science in the laboratory of the Botanical Department of Brown University under the direction of Dr. H. H. York. The writer wishes to acknowledge her indebtedness to Dr. York for collecting the samples of soil, for information regarding kinds of subsoil, for assistance in the identifications of the fungi and for suggestions. The writer is also indebted to the members of the United States Laboratory of Forest Pathology at Brown University for many helpful suggestions.

TABLE 9

List of fungi isolated from grubs and worms

	Large earth-worm	Grub	Small red earth-worm	May beetle	Small striped earth-worm	Large earth-worm	Large earth-worm	Grub	Large earth-worm	Grub	Large earth-worm	Large earth-worm	Large earth-worm	Large earth-worm	Large earth-worm	Large earth-worm
Date of collection	Jan. 23, 1917	Feb. 20, 1917	Feb. 20, 1917	Feb. 20, 1917	Feb. 20, 1917	Jan. 23, 1917	Mar. 16, 1917	Jan. 23, 1917	Mar. 16, 1917	Mar. 16, 1917	Jan. 23, 1917	Feb. 20, 1917	Mar. 16, 1917	Jan. 23, 1917	Mar. 16, 1917	Mar. 16, 1917
Depth of collection in inches	6-8	6-8	8-12	14	14	12	16	18	20	24	16	28-30	30	32	34	44
Aspergillus niger									*							
Fusarium sp	*	*			*		*	*	*			*	*		*	*
Mucor botryoides																*
Mucor heterogamus				*				*	*			*	*	*	*	*
Mucor sp	*				*						*		*		*	*
Mycogene?										*					*	
Oospora?															*	
Penicillia	*	*			*		*	*	*	*	*	*	*		*	*
Spicaria (silvatica?)		*	*				*		*	*		*	*		*	*
Trichoderma koningi	*	*			*				*		*	*	*	*	*	*
Zygorrhynchus vuillemini	*	*			*		*		*			*	*		*	*

TABLE 10

Summary of the fungi identified from soil of the Botanical Garden

Depth in inches	Surface	1	2	3	4	6	6-8	8	10	12	14	16	18	20	22	24	26	28	30	32	34	38	44
Aspergillus niger		*			*					*		*	*		*			*			*		
Fusarium sp.	*	*	*		*		*	*	*	*	*	*	*	*		*	*				*	*	
Mucor botryoides											*	*		*		*							
Mucor heterogamus	*	*			*	*		*	*	*	*	*	*	*	*		*	*			*	*	
Mucor sp.	*	*		*	*				*		*	*						*			*		
Mycogene?							*			*													
(Oospora lactis)?												*									*		*
Penicillia	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Rhizopus nigricans														*							*		
Spicaria (silvatica?)								*		*		*		*		*		*			*	*	*
Spicaria sp.																				*			
Trichoderma koningi	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Yeast											*	*		*	*	*		*	*	*	*	*	*
Zygorrhynchus vuillemini	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			*	*	*

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BRIEFER ARTICLES

ADDITIONAL LIST OF STATE AND NATIONAL QUARANTINES AGAINST THE WHITE PINE BLISTER RUST

ROY G. PIERCE

The following table supplements and corrects the original list of state and national quarantines as published in PHYTOPATHOLOGY 7: 319–321, August, 1917.

STATE	WHITE PINES	RIBES, GROSSULARIA	DATE	QUARANTINED AREA
United States	All	R. nigrum	1 My. 17	States of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut. Amends Quarantine No. 26 of 21 Ap. 17. which was effective 1 Je. 17
Georgia	All	All	1 My. 17	All points outside state
Illinois	All	All	25 S. 17	New England States, New York, Pennsylvania, New Jersey, Ohio, Wisconsin and Minnesota. Shipments are also prohibited entry from all other sources unless accompanied by a statement showing that plants therein were propagated and entirely grown in localities not included in above states, In Canada or in Europe or Asia
Indiana	All	None	24 Au. 17	All points outside state. Amends quarantine of 13 Mr. 17
Maine	All	All	21 S. 17	All points outside state, except by permit from Maine Forest Commissioner
Maryland	All	All	11 Ap. 17	New England States, New York, New Jersey, Pennsylvania, Minnesota, Wisconsin

STATE	WHITE PINES	RIBES, GROSSULARIA	DATE	QUARANTINED AREA
Michigan	All	All	19 Mr. 17	All points outside state, with proviso permitting shipment of currants and gooseberries into State under permit from Michigan State Nursery Inspector. Corrects data as given in PHYTOPATHOLOGY **7**: 320, Au. 1917
Minnesota	All	None	12 Je. 17 Effective 15 Jy. 17	New England States, New York, New Jersey, Pennsylvania, Ohio, Wisconsin, and Michigan amends Quarantine No. 1 of 30 Ap. 17
Montana	All	All	3 Jy. 17	All points east of and including Minnesota, Iowa, Missouri, Arkansas, and Louisianna amends quarantine of 17 Jy. 16
New Hampshire	All	All	27 Fe. 18	All points outside state. Shipments of all gooseberries and currants within the state is also prohibited
New Jersey	All	None	4 Jr. 17	New England States, New York, Pennsylvania, Michigan, Wisconsin and Minnesota
New York	All	None	6 Mr. 17	New England States, Pennsylvania, New Jersey, Ohio-Indiana, Illinois, Minnesota and Wisconsin
New York	None	All	17 Au. 17	Local control areas in New York (for the growing of white pine) within which no Ribes may be grown or into which no Ribes may be shipped[1]
Rhode Island	All	All	2 Ap. 18 Effective 8 Ap. 18	Permit from State Board of Agriculture necessary before white pines or gooseberries and currants are planted in state No planting of 5-leaves pines or plants of genus Ribes permitted in towns of Coventry and West Greenwich

STATE	WHITE PINES	RIBES, GROSSULARIA	DATE	QUARANTINED AREA
Rhode Island	All	All	2 Ap. 18 Effective 8 Ap. 18	Planting of black currants and flowering currants is prohibited within the state
S. Carolina	All	All	2 Mr. 17	All points outside state
S. Dakota	All	All	3 Ap. 17	New England States, New York, New Jersey, Pennsylvania, Ohio, Wisconsin, and Minnesota. Corrects data as given in PHYTOPATHOLOGY **7**: 321, Au. 1917.
Vermont	All	None	26 Ap. 17 Effective 1 My. 17	All points outside state.

[1] Clinton County, N. Y. Towns of Au Sable, Black Brook and Peru.

All of Columbia County, N. Y., except the Town of Greenport, Kinderhook, Livingston, Stockport, Stuyvesant, Germantown and Clermont.

All of Essex County, N. Y.

Niagara County, N. Y., Towns of Porter, Lewiston and Niagara.

Rensselaer County, N. Y. Towns of Berlin, Petersburg, and Stephentown.

All of Warren County, N. Y.

All of the Adirondack Park and Catskill Park as defined in Chapter 451, Laws of 1916.

BUREAU OF PLANT INDUSTRY
DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

REVIEWS

An Outline of the History of Phytopathology. By Herbert H. Whetzel. 12mo. 130 pp., 22 portraits. 1918. W. B. Saunders & Co., Philadelphia, Pa.

Phytopathology as an organized and separate branch of botanical science is of very recent origin. It however has had a very interesting development and can be traced in its beginnings back to the early ages. The aim of the work before us, as stated by the author, is "to set forth in outline what appear to be the most outstanding features in the evolution of the science and to indicate the proper relation thereto of the men who have chiefly shaped its progress." Five eras are recognized. The Ancient Era, the Dark Era, the Premodern Era, the Modern Era and the Present Era. Each era is divided into periods with a brief discussion of the principal men and contributions to the subject during these periods. Under the Ancient Era mention is made of some of the records of the Hebrews, Greeks and Romans. Very little of importance appeared during the Ancient and Dark Eras or Middle Ages. The references to plant diseases during these eras are interesting but usually shrouded with superstition and error, though many suggestive observations and important facts are recorded by the Greeks and Romans, some of which are even today put forth as new discoveries. The Premodern Era covers 1600 to about 1810. The work of Zallinger, Tournefort, Fabricius, Unger, Wiegmann, Meyen and others is discussed. The belief in spontaneous generation and the autogenetic origin of plant diseases was the predominating influence during this era.

The author divides the Modern Era (1853 to about 1906) into two periods, the Kühnian Period (1853 to 1883) and the Millardetian Period (1883 to 1906). Beside Kühn, de Bary, Pasteur and Berkeley were the outstanding workers during this period. Improved facilities and more thorough methods of research in the hands of such able investigators soon demonstrated the falsity of the spontaneous generation idea and firmly established the parasitic nature of many plant diseases.

The Millardetian Period is characterized by the discovery of Bordeaux mixture and the great development and application of methods of disease prevention and control. It also includes the work of all the great investigators of the last quarter of the nineteenth century.

The Present Era, which dates from 1906, has shown the greatest developments and advance in America. Plant Pathology has been recognized in the universities by the establishment of regular and special courses in the subject. The American Phytopathological Society, including all the workers in the country and its journal, PHYTOPATHOLOGY, have greatly stimulated work and advanced our knowledge of the subject. Great advances in the economic aspects have been made in the development of sulphur fungicides and the breeding of disease resistant plants. As the author justly remarks, we are too near the events of this era to properly estimate their relative importance.

The volume is well printed and the many excellent portraits of the makers of plant pathology add much to its attractiveness and value.

This outline should be exceedingly useful to all teachers and students of plant pathology as well as the general student of science. A knowledge of the history and development of any subject is essential as a foundation for the most successful and profitable work in that subject. A blind worship of authority based on ignorance is as bad as a refusal to recognize any authority. It is only by a study of the history of the subject and the men who have made it, that one can get a true perspective and correctly evaluate the work of his predecessors and properly direct and correlate his own work.

It is to be hoped that the author will continue his studies along this line and eventually give us a more complete work on the subject.

C. L. SHEAR.

PHYTOPATHOLOGICAL NOTES

Bacterial oat blight. During the past season an unusually severe bacterial blighting of oats has occurred in southern Wisconsin. A similar condition was reported for southern Minnesota, northern Illinois, northern Indiana, and Ohio. The signs were most evident during the last two weeks in May and early in June, following a period of driving rains and cool cloudy weather. All the fields observed showed the disease, the amount varying from 1 to 100 per cent of plants infected. Late in May few fields showed the normal blue-green color throughout, and even these on closer inspection showed scattered lesions on the lower leaves. Most of the fields were of a somewhat lighter shade than normal due to blighted yellow leaves and leaf tips among the uninfected leaves. Distinctly yellow spots from a few feet to a rod or more in diameter were quite common in the fields and where infection was most severe whole fields or parts of fields were yellowed. Following the warmer dry weather early in June, most of the oat fields recovered, resuming their normal blue-green color through the growth of new uninfected leaves.

While two distinctly different bacterial diseases of oats have been observed, field observations and reports, and specimens from various parts of Wisconsin show one disease—the "halo blight"—to be much the more general. The typical lesion of this halo blight, in an early stage, is an oval chlorotic area about a minute center of sunken dead tissue. The small grey-brown spot of collapsed tissue, the central infection area, varies from one to several millimeters in diameter and the surrounding oval yellowish-green halo-like margin from 1 to 2 or more centimeters. This halo is conspicuous and characteristic, its tissues continuing alive for some time and having a normal appearance except for the paler yellowish color. In some cases the halo may be prolonged as a yellow streak throughout the length of the leaf. Frequently there are several lesions on the same leaf, which, as they coalesce, produce a general yellowing followed by a breaking across of leaf blades or a shriveling and drying of the tips or margins. The tissues are not water soaked and there is no bacterial oozing or surface exudate. During periods of warm dry weather the yellowed halo tissue loses its turgidity and color and forms oval, grey-brown, dead spots which sometimes have narrow brown margins and on other leaves narrow yellow halo-like margins. Sometimes the dead tissue assumes a pinkish or reddish brown color. In separate lesions the oval

outline of the halo persists and even when the whole leaf becomes brown and dry, original halo outlines may be distinguished. The characteristic halo lesions of this disease have been definitely observed in Wisconsin during each of the past five years and are similar to those figured by Manns[1] (Pl. XIII) in his Ohio Bulletin of 1909. The results of the writer's work on halo blight of oats agree with those reported by Jones, Johnson, and Reddy[2] in that typical halo lesions are readily produced by a white bacterial pathogene alone.

In addition to this halo blight, another distinctly different bacterial disease has been found on oats. It was first collected by Dr. A. G. Johnson at Urbana, Ill., in June, 1917, and later by him at La Fayette, Ind., and Wooster, Ohio. At Madison, Wis., this same disease is occurring in two widely separated fields. The lesions are characteristically different from those of the halo blight. The tissues are water soaked, somewhat translucent and usually extend as long, rather narrow, sharply delimited streaks between the veins, or may occur as elongated spots of brown water soaked tissue. There is no halo-like border and the lesions soon become rusty brown in color with dry translucent centers. Exudate is abundant, appearing first as turbid white beads which dry down into glistening white films or flakes. The absence of the halo and evidence of exudate serve as important diagnostic characteristics of this disease, which is tentatively being called "stripe blight." A white bacterial pathogene has been isolated from these lesions which reproduces the typical lesions in artificial infection experiments.

CHARLOTTE ELLIOTT.

Drouth injury to McIntosh apple. Comparatively few records of injuries due to drouth exist in the treatises on fruit diseases. It would appear very desirable to deal with this subject in a manner similar to the recent descriptions of lightning injury.

The accompanying drawing shows a young fruit of a McIntosh red apple from the Okanagan Valley, British Columbia. Owing to the difficulty of photographing these deeply colored small fruits to show the injury, a drawing had to be resorted to. The fruits when received were but slightly limp and shriveled. They were covered with a large number of more or less confluent, sunken-in, brown spots, irregular in shape and outline. On examination it was determined that these spots were not of parasitic origin and extended but little into the interior of the

[1] Manns, T. F. The blade blight of oats—a bacterial disease. Ohio Agr. Exp. Sta. Bul. 210, 91–167. 1909.

[2] Jones, L. R., Johnson, A. G., and Reddy, C. S. Bacterial blight of barley. Jour. Agr. Res., Vol. XI, No. 12, 1917.

fruit. On cross sectioning the fruit we observed a very pronounced darkening of the vascular bundles, which was later recognized as a necrosis of the vascular system. These were the principal symptoms observed.

Apples from the same orchard in 1917, though received somewhat later in the season, showed very irregular size and the same external discoloration. The crop was reported to be very severely damaged. In June, 1918, apples from the same orchard were examined, the symptoms being as described, and the crop a total failure. We cannot account for the nature of this trouble but from the extraordinarily severe drouth of 1917 and from lack of precipitation—from January up to July, less than two inches—we are inclined to attribute the cause to the persistent drouth, increased in this case by the gravelly nature of the soil. It is evident that a necrosis present where shown in the figure would result in

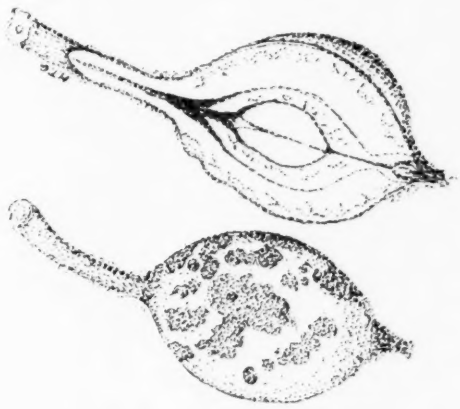

FIG. 1. DROUTH INJURY TO MCINTOSH APPLE

cutting off the supply of moisture to the fine vascular network close to the skin of the apple, which would then most likely result in the formation of the dead areas. It is hoped that this preliminary note may stimulate observations and eventually result in the discovery of the true cause.

H. T. GÜSSOW.

Observations on obscure potato troubles. I. Heterodera radicicola. This eelworm caused considerable trouble to tomato plants raised in a greenhouse. In order to test whether this eelworm might through carelessness become a source of trouble to potatoes, a young tomato plant with badly galled roots was taken up and transplanted into a flower pot. As soon as the plant had become established, the top was cut off just above the

ground and a sound potato tuber was then planted into the same pot. At harvest time two small tubers had formed, with the results plainly visible in the accompanying photograph (fig. 2). The eelworms had thoroughly established themselves from the eye end down. They were present in large numbers, but apparently only females. Whether the numerous eggs in situ reproduced parthenogenetically males, cannot be said, but it seems likely that such was not the case since on planting the diseased

FIG. 2. POTATO TUBER INJURY BY HETERODERA RADICICOLA

tubers, there were produced about eleven perfectly sound tubers, which on microscopical examination revealed no eelworm attack whatsoever.

Throughout these experiments, the plants were kept in pots in the greenhouse.

II. Unfavorable storage conditions. In 1904, when assisting Wm. Carruthers, F.R.S. in England, a sample of potatoes received from Lincolnshire, England, was examined, which showed numerous bluish black warts of about $\frac{1}{4}$ inch in diameter. The warts showed plainly on peeling and consisted of hard browned cells containing the hyphae of a fungus.[1]

[1] Carruthers, Wm. Ann. Report for 1904, Roy. Agric. Soc. of England, Vol. 65, 1904.

The cause was not determined. Since those days the identical trouble has been observed in Canada in potatoes from Quebec, New Brunswick and British Columbia. This trouble invariably showed up in badly ventilated storage cellars, particularly when the potatoes in the cellars were covered with soil to prevent freezing. These conditions greatly interfere with the normal respiration of the resting tubers and result in the production of the symptoms shown in figure 3.

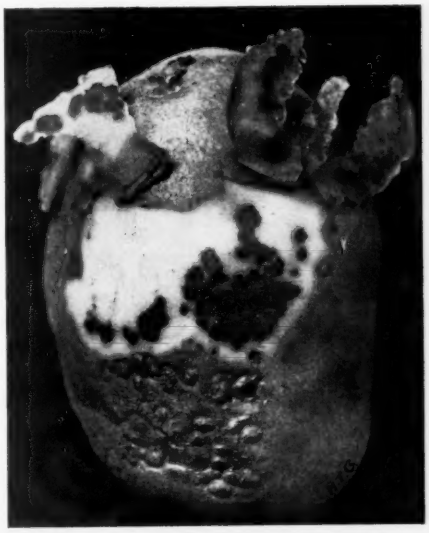

FIG. 3. POTATO TUBER INJURY ATTRIBUTED TO UNFAVORABLE STORAGE CONDITION

III. Leaf streak. In severe cases of mosaic disease there may be present in the leaf small portions of dead veins which by some investigators appear to be called streak. In the several cases that have come to our attention, one of which is shown in figure 4, the leaves showed a network of dark brown lines following the leaf veins, with a similar color feebly diffusing into the surrounding tissues. The affected leaves gradually turn yellow and finally die. The symptoms show up very suddenly towards the end of the vigorous growing season and the leaves are quickly killed. At times the leaf stalk will show one or more dark streaks in its interior when it is held up against the light. The trouble looks typical enough for a bacterial disease, but so far, isolations of any kind of organism have proved unsuccessful. As will be seen in the photograph, the plant from which this leaf was taken showed no

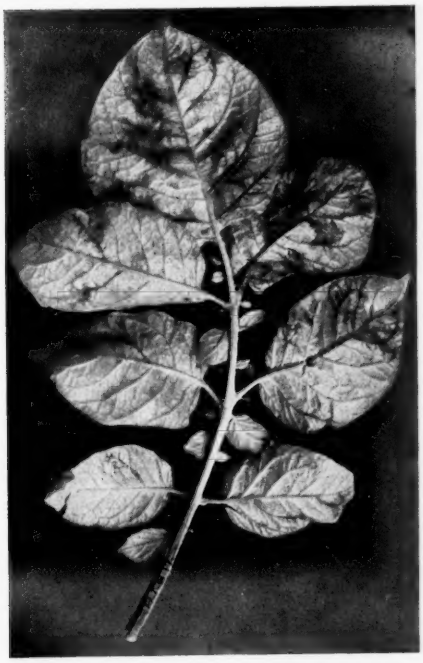

FIG. 4. POTATO LEAF STREAK DISEASE

FIG. 5. MOSAIC DISEASE OF POTATO

mosaic disease. This trouble has been observed in Eastern Canada and from reports received it apparently exists in the U. S. A. and in the islands of Bermuda. The cause of this vascular necrosis is not known The tubers collected from affected plants reproduce the trouble when planted. The tubers show no signs of any necrosis.

IV. Mosaic disease transferred by inarching. After various unsuccessful attempts at conveying mosaic disease by contact to healthy plants, the shoot of a very pronouncedly diseased plant was grafted by the inarching method to the shoot of a vigorous, sound plant. Union was perfectly established and eventually the diseased shoot was severed from its plant and allowed to remain on the sound plant. During no time were observed symptoms of mosaic in the sound plant. At harvest time four tubers were produced. On planting these, every shoot produced showed typical mosaic disease. The photograph shows two of the plants used in the experiment. (Fig. 5.)

H. T. Güssow.

Laboratory notes on cultures of Endothia parasitica, A. & A. Notes on the color reactions of reproductive and vegetative hyphae of E. parasitica when treated with chemicals. Ten per cent sodium hydroxide poured over cultures growing on cornmeal agar turned the pycnidia a magenta color and streams of magenta colored conidia arose from them. The vegetative hyphae did not change color, nor did the cornmeal agar. Solutions of sodium carbonate, lithium carbonate, ammonium carbonate and ammonia

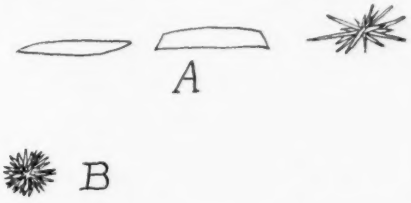

FIG. 6. CRYSTALS FROM ALCOHOLIC SOLUTION OF COLORING MATTER FROM REPRODUCTIVE HYPHAE OF ENDOTHIA PARASITICA

A, Formed on addition of sulphuric acid, *B*, formed as alcoholic solution evaporated.

colored pycnidia and perithecia whether in artificial culture or growing on wood. Alcohol dissolved the coloring matter from the reproductive hyphae. An orange-colored solution was formed which was acid to litmus paper. Alkalies changed its color to magenta. The addition of sulphuric acid to the alcoholic solution produced small, pale yellow crystals, which were sometimes arranged in star-like groups (A). A solu-

tion of iodine and potassium iodide produced a greenish yellow color. When the alcoholic solution was allowed to evaporate, two kinds of crystals appeared, one kind deep red in color, minute, flat, sword-shaped crystals, some of which had pointed ends, some blunt. These crystals were arranged in such compact bundles that the individual crystals were not readily seen with magnification (B). They did not dissolve in cold water. The other kind of crystal was pale yellow in color, sword shaped, often arranged in star-like groups. Pycnidia treated directly with iodine and potassium iodide formed reddish-brown globules inside the hyphae, while without globules collected. Dilute sulphuric produced brown globules outside the hyphae. In 48 hours small sword-like crystals appeared in the neighborhood of the hyphae, resembling those found in the alcoholic solution. Concentrated sulphuric caused brown globules to form outside the hyphae, and on adding potassium bichromate the globules turned green. Picric acid in 50 per cent alcohol produced a green, oily substance. Vegetative hyphae did not appear to react to chemicals aside from the fungus cellulose reaction. Tests made for the presence of phloroglucin and tannic acid on mycelium grown on cornmeal agar proved negative.

Effect of the fungus on the media. Experiment 1. Medium 1 per cent glucose solution. Two flasks inoculated with conidia.

April 27, 1912. One flask control.

	JUNE 3. TITRATED DIRECT WITH N/20 NaOH CALCULATED TO OXALIC	ANALYSIS MADE. ADDED EXCESS OF Ba (OH), TITRATED BACK WITH N/20 NaOH TO OXALIC	DISTILLED "A" RESIDUE TITRATED DIRECT WITH N/20 NaOH	TWO-THIRD PORTION DISTILATE TITRATED DIRECT WITH NaOH N/20	RICHARD'S TEST FOR CO_2 PARTS PER MILLIGRAM
	per cent	*per cent*	*per cent*		
Inoculated no. 1 flask....	0.0085	0.0023	0.0028	2 drops made alkaline	2.09
Inoculated no. 2 flask....	0.0081	0.00165	0.00127	2 drops made alkaline	1.04
Control no. 3.....	0.00088	None	0.000943	1 drop made alkaline	0.68

The presence of an unknown acid, non-volatile, reported.

Experiment 2. The following media were tested for acidity, July 18th.

a. Boiled chestnut juice and twigs, inoculated with conidia April 18. Fungus alive. Acid to litmus, with trace of tannic and gallic acid.

b. Boiled oak juice, inoculated with conidia April 20. Fungus alive. Neutral to litmus. No trace of either tannic or gallic acid.

c. Boiled sumac juice and twigs, inoculated June 5. Fungus alive. Acid to litmus, with trace of tannic and gallic acids.

Test for tannic acid: 1 per cent gelatin, 10 per cent salt solution.[1]

Test for gallic acid: $FeCL_2$.

Experiment 3. Three flasks of boiled chestnut juice inoculated with conidia July 5. One flask control. Fungus grew and fruited on surface of media of three flasks. November 20, the three cultures show the fungus beneath the surface of the media, except for a few streaks of mycelium. No fruiting pustules seen. December 17, about five and one-half months later, the juice was tested by Mr. O. F. Black, Chemical Biologist of the Bureau of Plant Industry, in the following manner.

"The juice was filtered through a dry filter and 10 cc. of the filtrate removed with a pipette, diluting largely with distilled water and titrated against N/20 NaOH using phenolphthalein as an indicator. Since the high color of the solutions rendered the end of the reaction indistinct, an attempt was made to bleach with bone black, but with not much effect. The titrations were carried out and checked by means of a control solution as a color comparison, which gave fairly sharp results, as follows:

Flask 1. 10 cc. filtrate neutralizes 2.15 cc. N/20 NaOH.
Flask 2. 10 cc. filtrate neutralizes 2.20 cc. N/20 NaOH.
Flask 3. 10 cc. filtrate neutralizes 1.55 cc. N/20 NaOH.
Control 10 cc. filtrate neutralizes 3.50 cc. N/20 NaOH.

Notes on flasks cultures show that while at first oak and chestnut juice prove excellent media, later they seem to hold substance inhibitive to the fungus.

It would appear from experiment 2 that the acid reaction of the medium was closely connected with the presence of tannic or gallic acid, for the media gave acid reactions only when they were traces of these two acids. The glucose medium in experiment 1, where there was neither gallic or tannic acid, show an increased acidity due to the presence of the growing fungus. It would seem then from experiment 2 that the activity of the fungus mycelium produced a compound or compounds which either destroyed the gallic and tannic acids in the boiled tree juice, or combined with them in such a way as to prevent the reactions ordinarily given by these acids when treated with certain reagents.

Toxins. It was soon realized the hyphae contained a substance or substances toxic to their own growth. It was a question whether the toxin could escape through the walls of the hyphae after death, only (a phenomenon common to many pathogenic bacteria), or whether it passed through the living fungus cell walls and simply accumulated in the sub-

[1] Solutions in experiments 1 and 2, titrated by Joseph Shrawder of the Pennsylvania Chestnut Blight Commission.

stratum. There was also the possibility that both these phenomena occurred.

A simple experiment with cultures growing on cornmeal agar indicated that the death of the mycelium could cause an alkaline reaction of the medium.

Experiment 4. Cornmeal agar cultures were cut up and stirred about with a scalpel so thoroughly that no further growth of mycelium appeared. The tubes were laid aside and examined from time to time. With the lapse of several days the agar gradually turned plum colored; its reaction to litmus paper alkaline. The original color of the medium was white, its reaction to litmus paper acid. Undisturbed cornmeal cultures kept this color and reaction. A small amount of dilute nitric acid quickly removed the plum color.

Experiment 5. Boiled oak juice was inoculated with conidia. After the fungus had covered the surface of the juice and produced numerous fruiting pycnidia, the culture was thoroughly shaken. A small amount of mycelial growth appeared on the surface. It was shaken again, also inoculated directly with conidia. A small amount of growth again ensued. Two months after the last inoculation the culture was passed through a Chamberlain filter. This filtrate was directly inoculated with conidia, which started to germinate, but after this ceased growth.

Experiment 5. Conidia were introduced into 3 tubes of melted but cool cornmeal agar, the tubes thoroughly shaken and contents of each poured into petri dishes. Dish 1 contained few; dish 2 many; dish 3 large quantities of conidia distributed evenly throughout the agar. The conidia in the three dishes germinated and started growth at the same time. Dish 1 produced a typical normal growth; dish 2, showed a slight amount of mycelium while a microscopic examination of agar from dish 3, showed that the germinating tubes had scarcely lengthened. Transfers were made from the three petri dish cultures to fresh cornmeal agar. All these transfers showed good growth. Ten days after the conidia had been sown, transfers were made of pieces of agar with mycelium from each of the three cultures to the other two respectively, i.e., from petri dish 1, to dish 2 and dish 3, from dish 2, to dish 1 and dish 3, etc. Five days later it was seen that in not one case had the transferred mycelium left the agar on which it had been growing for the new substratum. Transfers were then made from dishes 1, 2 and 3, to fresh cornmeal agar; those from dish 1, grew, but not those from dishes 2 and 3.

From these results it would appear that the mycelium in petri dishes 2 and 3, had quickly stopped growing, although alive and capable of growth when transferred; they died in a comparatively short time and the substratum on which they had grown could not sustain living mycelium.

Hydrogen electrode tests. Cook's medium. Inoculated with *Endothia parasitica* on October 21, 1914.

Tested March 1, 1915. 131 days after inoculation. 3×10^{-7}.

Control. Cook's medium. 5.5×10^{-7}. (Loss of acidity about 50 per cent).

Water extract of healthy chestnut: Inoculated January 14, 1914. Tested March 1, 1915. 1.1×10^{-3}.

Control 2×10^{-3}. (Loss of acidity about 50 per cent.)

Toasted bread and water: Fungus alive. Inoculated January 14, 1914. Tested March 1, 1915. 2.5×10^{-6}.

Control. 1.3×10^{-6}. (Gain of acidity about 50 per cent.)

Water extract of chestnut blight canker: Inoculated January 14, 1914. Tested March 1, 1915. 1.1×10^{-7}. (This is about the neutral point.)

These tests were made by Dr. William Bovie of the Medical School of Harvard University.

CAROLINE RUMBOLD.

Personals. Mr. R. O. Cromwell, formerly of the North Carolina Agricultural Experiment Station and more recently a graduate student at the University of Nebraska, has accepted an appointment in the Office of Cotton, Truck and Forage Crop Disease Investigations, Bureau of Plant Industry as extension pathologist for the state of Iowa, with headquarters at Ames.

Dr. Ruth F. Allen, professor of botany at Wellesley College, has been appointed assistant pathologist in the Office of Cotton, Truck, and Forage Crop Disease Investigations, Bureau of Plant Industry.

Mr. E. C. Sherwood, a recent graduate of the Oklahoma Agricultural College, has entered the service of the Bureau of Plant Industry and will take the leadership in work on the control of cotton, truck, and forage crop diseases in Oklahoma, with headquarters at Stillwater.

Mr. V. H. Young, formerly professor of botany at the Iowa State University, has been appointed assistant pathologist in the Bureau of Plant Industry and will take up work on the pathological aspects of markets inspection of vegetables.

Mr. A. H. Gilbert has been transferred from the position of pathological inspector for the Federal Horticultural Board to that of assistant pathologist in the Office of Cotton, Truck, and Forage Crop Disease Investigations, B. P. I., and will be engaged in pathological extension work in Vermont, with headquarters at Burlington.

Dr. M. F. Barrus, professor of extension work at Cornell University, has secured a year's leave of absence to accept a position in the Bureau of Plant Industry as pathological adviser in extension work on the control of diseases of truck and forage crops in the northern and western states, with headquarters at Washington, D. C.

Mr. W. S. Fields, formerly assistant plant pathologist of the Arkansas Experiment Station and instructor in plant pathology in the Arkansas College of Agriculture, has been appointed by the Bureau of Plant Industry as extension pathologist for the state of Mississippi, with headquarters at Agricultural College.

APPENDIX

FOURTH ANNUAL CONFERENCE OF CEREAL PATHOLOGISTS

LAFAYETTE, INDIANA, JUNE 19–21, 1918

The Fourth Annual Conference of Cereal Pathologists was held at Purdue University, Lafayette, Indiana, June 19 to 21, 1918. Forty persons were present.

The principal topics of discussion were rust control and the campaign for barberry eradication, and the smuts of small grains and their control.

The following resolutions were adopted:

1. We, the Cereal Pathologists in conference assembled at Lafayette, Indiana, after summarizing the evidence accumulated against the barberry as a spreader of black stem rust;

Do heartily endorse the efforts now being made under the leadership of the Department of Agriculture for the eradication of the forms of barberry and Mahonia, susceptible to black stem rust as a war measure of special importance in the conservation of our cereal food supply.

And be it resolved that we urge upon the Department of Agriculture and the agricultural agencies of the various states that the work be extended as speedily and pushed as vigorously as possible in order to give maximum production.

2. Whereas, the control of cereal smuts is of paramount importance and whereas, it is essential to learn the effect of different treatments on seed germination and yield, as used upon various cereals in various regions, under different conditions and on various varieties and seed lots with a view to standardizing treatments insofar as possible. Be it therefore resolved, that we Cereal Pathologists urge (1) The continuation of the present smut eradication campaign U. S. Department. (2) Endorse and support the efforts now being made under the auspices of the War Emergency Board to solve the problems in connection with cereal seed treatment.

3. Whereas, Dr. J. C. Arthur, with rare devotion to science and foresight into the problems of the future has done a tremendous amount of work fundamental to the development of cereal pathology.

And whereas, recognizing the fine service he had rendered we wish to express our appreciation of and admiration for this self-sacrificing work.

Be it, therefore resolved that we, the Cereal Pathologists assembled at Lafayette, Indiana, June 19–21 do hereby express a sincere vote of thanks to Dr. Arthur for the concrete results he has obtained and the inspiration he has furnished, and be it further resolved, that a copy of this resolution, be sent to Dr. Arthur and also be published in Phytopathology.

4. Whereas, a large quantity of wheat is being imported into the United States from Australia for food purposes and

Whereas, some of the wheat so imported may be used for seed purposes and

Whereas, certain wheat diseases prevalent in Australia and not now in this country, may thereby be introduced into our country

Be it resolved, by the Cereal Pathologists assembled at Lafayette, Indiana, June 19–21, that the Horticultural Board be requested to take immediate steps looking toward the prevention of the introduction of such diseases.

BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

CHAS. W. HUNGERFORD,
Secretary.

BERKELEY CONFERENCE

REPORT OF THE FIRST WAR EMERGENCY CONFERENCE OF THE PLANT PATHOLOGISTS OF THE WEST WITH THE PACIFIC DIVISION OF THE AMERICAN PHYTOPATHOLOGICAL SOCIETY AT BERKELEY, CALIFORNIA, MARCH 30, 1918

The meeting was called to order in the rooms of the Department of Plant Pathology by H. P. Barss of the Oregon Agricultural College, Commissioner for the West on the War Emergency Board and President of the Pacific Division of the American Phytopathological Society. Thirty were in attendance.

Chairman H. H. Whetzel of the War Emergency Board explained the origin of the Board and the work it is doing, stating that it has no governmental authority but hopes to accomplish valuable results by its advisory powers and through its efforts to stimulate and coordinate essential war work in plant pathology. He urged the desirability of presenting to the conference information and ideas which might prove of use in the present emergency, whether previously published or not, and proposed the adoption of projects providing for the cooperative investigation of pressing problems of war importance.

Commissioner F. D. Kern of the War Board explained the man-power census which has already rendered considerable service in bringing available men and needed work together. In the absence of Commissioner G. R. Lyman on account of illness, he also explained the work of the Plant Disease Survey and the importance of the information it is designed to secure as an aid to both research and extension work.

Announcement was made of the establishment of a national war assignment committee consisting of Dr. L. R. Jones, F. D. Kern, Dr. E. M. Freeman, and one other to be appointed by the Western Conference to take up and bring to the proper Federal authorities cases where local exemption boards have assigned to military service men absolutely needed for war emergency work in plant disease prevention.

By vote of the conference Dr. E. Meinecke of San Francisco was elected to represent the West on this committee. All cases demanding attention within the western district should be made known at once to Dr. Meinecke, care of the Forest Service, San Francisco, California.

The more important phytopathological problems of the West were taken up in general discussions, during the course of which many interesting and important suggestions were brought forward. Cooperative emergency research projects were then adopted and leaders appointed.

The problems connected with the prevention of the smuts of cereals were the first to be considered. Attention was called to the matter of seed treatment injury and the need for a careful study of the factors involved; the difficulties of coping with the soil infection, in the case of fall planted wheat, resulting from spore showers at threshing time; and the doubtful practicability of soil treatment was discussed. The work of the Bureau of Chemistry of the Department of Agriculture, aiming at the prevention of smut explosions and the removal of smut by suction fans attached to threshing machines was presented by Dr. Brown of that Bureau. Dr. Heald of Washington State College reported some of the results of experimental work carried on at that institution and called attention to the value of reploughing summer fallow. Mr. Woolman of the Department of Agriculture described a new double disc drill to be tried out this season, which plants the seed wheat in the bottom of a furrow in such a manner as to prevent the seed from coming in contact with smut-contaminated surface soil. Professor Mackie of California stated that the loose smuts of wheat

and barley apparently were unable to perpetuate themselves under California conditions. Dr. Heald reported that the covered smut of oats predominating in Washington does not seem to yield to the usual treatments as well as the loose smut predominating in the East.

Fruit diseases were taken up and an interesting discussion of dusting as a means of control for various diseases was led by Dr. Whetzel. This was followed by the presentation by Prof. R. E. Smith of his new method of preparing fungicidal and insecticidal dusts in which kaolin is used as an absorbent for the solution containing the active element after which it is dried, pulverized and applied in dust form. Although the work is still in the experimental stage, the results already obtained point to large possibilities. Very great interest was manifested by the conference in this method. The consideration of spraying and dusting led to a discussion of the need for a systematic study of fungicidal materials on a more adequate basis than hitherto and a committee was appointed to draw up resolutions expressing the ideas of the conference on this subject. The need for greater attention to extension work and demonstrations in fruit disease control was also brought out.

The importance of emergency work on potato diseases was discussed and particular attention was called to the need for further study throughout the United States of the wilt diseases and the storage rot problem. Rhizoctonia was also pointed out as one of the most serious problems needing broad cooperative study at this time. Some consideration was also given to the diseases of beans, onions, truck crops, forage crops, corn, sugar beets and nut crops.

War emergency problems in forest pathology were presented by Dr. Meinecke. He spoke of the great danger which might threaten the West if the White Pine Blister Rust problem should be neglected; and called particular attention to the serious results of the failure of the Government to employ trained forest pathologists for the inspection of timber to be used as war material. The dangers arising, especially in airplane construction from the failure of ordinary inspectors to detect advance rot were pointed out. The unwisdom of the Government in taking men trained for such important war work and placing them in ordinary military service was commented upon. The seriousness of the situation was emphasized in the discussion which followed and the conference urged Dr. Meinecke to take up with the national committee without delay the matter of having the trained forest pathologists now in the army detailed back for timber inspection work in the lumber camps and mills.

Before adjournment it was voted as the sense of the meeting that another conference be held if possible next fall to check up on the results of the work accomplished during the present season and to lay plans for the future.

MINUTES OF THE BUSINESS MEETING OF THE PACIFIC DIVISION OF THE AMERICAN PHYTOPATHOLOGICAL SOCIETY

The meeting was held in the plant pathological laboratory of the University of California, March 30, 1918, at 5.20 p.m., President Barss presiding and nineteen members present.

Report of the previous meeting as published in PHYTOPATHOLOGY, Vol. VII, No. 2, was accepted without reading.

It was unanimously voted to adopt the following resolution in acceptance of the invitation of the Pacific Division of the American Association for the Advancement of Science inviting this Society to become affiliated with it:

"*Be it resolved:* That the Pacific Division of the American Phytopathological

Society accept the invitation to become affiliated with the Pacific Division of the American Association for the Advancement of Science."

The President expressed thanks of the Society for courtesies extended by the Division of Plant Pathology and the University of California.

The following officers were unanimously elected for the ensuing year: President, Dr. F. D. Heald, Pullman, Washington; Vice-president, Dr. E. P. Meinecke, San Francisco, California; Secretary-treasurer, Prof. W. T. Horne, Berkeley, California.

Meeting adjourned.

Resolution adopted

WHEREAS: The Pathologists of the Pacific Division of the American Phytopathological Society in session at Berkeley, California, to consider War Emergency measures are cognizant of the advisability of having available a greater number of fungicides for general and specific uses, and

WHEREAS: They feel that it should be possible to discover materials that are as efficient as the standard fungicides now in use but which are less injurious to the host plant, and

WHEREAS: They feel the need for having the new fungicides that manufacturers place on the market from time to time tested, and

WHEREAS: They feel that such investigations should be carried on by pathologists and chemists working in cooperation, and

WHEREAS: They feel that because of the wide application the problem is more appropriately Federal than state, therefore

Be it resolved that they urge the Chief of the Bureau of Plant Industry to take such action as is necessary to institute and carry on such investigations, and

Be it further resolved that copies of this resolution be forwarded to the Chief of the Bureau of Plant Industry.

LIST OF COOPERATIVE RESEARCH PROJECTS AND LEADERS

Adopted by the Plant Pathologists of the Western Division in Conference at Berkeley, California, March 30, 1918

No 1. *The Control of cereal smuts.* Leader: Dr. F. D. Heald, State College of Washington, Pullman, Wash.

No. 2. *Rhynchosporium (Marsonia) diseases of barley.* Leader: Dr. James McMurphy, Stanford University, California.

No. 3. *Methods and materials for the control of diseases by dusting.* Leader: R. E. Smith, University of California, Berkeley, California.

No. 4. *Fusqrium and Verticillium diseases of potato.* Leader forthe West: M. B. McKay, Oregon Agricultural College, Corvallis, Oregon.

No. 5. *Rhizontonia.* Leader: Dr. F. D. Heald, State College of Washington, Pullman, Wash.

No. 6. *Timber rots and timber inspection.* Leader: Dr. E. P. Meinecke, Forest Service Office, San Francisco.

No. 7. *Walnut blight control.* Leader: Prof. R. E. Smith, University of California, Berkeley, California.

No. 8. *Alfalfa diseases.* Leader: Dr. F. R. Jones, Bureau of Plant Industry.

No. 9. *Curly top of sugar beets.* Leader: R. E. Smith, University of California, Berkeley, California.

For more detailed information pathologists are invited to consult Commissioner for the West, H. P. Barss, Corvallis, Oregon, the Secretary of this conference, or any of the project leaders.

WM. T. HORNE, *Secretary*,
University of California, Berkeley, California.

LITERATURE ON PLANT DISEASES[1]

COMPILED BY EUNICE R. OBERLY, LIBRARIAN, BUREAU OF PLANT INDUSTRY, AND FLORENCE P. SMITH, ASSISTANT

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[1] This list includes references, both American and foreign, to the literature of plant pathology and mycology of interest to pathologists. Foreign references published since January 1, 1917, have been included beginning with the list appearing in v. 7, no. 3, June, 1917.

[2] All authors are urged to cooperate in making the list complete by sending their separates and by making corrections and additions, and especially by calling attention to meritorious articles published outside of regular journals. Reprints or correspondence should be addressed to Miss E. R. Oberly, Librarian, Bureau of Plant Industry, U. S. Dept. Agric., Washington, D. C.

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